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ABSTRACT

A comprehensive review of science education research revealed the lack of studies related to the act of reading. Reasons for the apparent lack of research attention to the reading area include: (1) reading is not needed in science teaching; (2) reading is needed but it is not frequently used; and (3) reading is needed and used but not identified by investigators for isolation or study. Since researchers in science education often dismiss or avoid instructional questions dealing with reading and textbooks (as illustrated by their reported studies) and many teachers are uninformed about reading research, a central issue in science education research is to close the gap among researchers, science teachers, and reading educators. Three reading-related domains of potential interest to these individuals include: how science educators can compose, select, and use science textbooks and other materials; the theoretical and applied relationships between the intellectual process skills of science and reading skills; and the use of such non-school print materials as "Newsweek" and scholarly materials like "Scientific American." One mechanism for achieving these goals is for science and reading educators to acquaint themselves with each other's theoretical orientations and not be limited by theoretical issues and methodological techniques. (JN)

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Learning from Science Texts and Materials:

Issues in Science Education Research

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Guthrie (1983) reviewed a series of meta-analysis studies orchestrated by Ronald Anderson (1983) and published in the Journal of Research in Science Teaching, describing a large proportion of research work in science education. Findings from these analyses were categorized into six groups -- categories similar to the ones traditionally used by other reviewers to classify research findings annually reported in the research journal, Science Education. The six major issues were phrased in the form of questions:

1. What are the effects of different curricular programs in science?
2. What are the effects of different instructional systems used in science teaching (e.g., programmed instruction, mastery learning, departmentalized instruction)?
3. What are the effects of different teaching techniques (e.g., questioning behaviors, wait time, advanced organizers, testing practices)?
4. What are the effects of different pre-service and in-service teacher education programs and techniques?
5. What are the relationships between science teacher characteristics and teacher behaviors or student outcomes?
6. What are the relationships between student characteristics and student outcomes in science?

Guthrie (1983), director of research for the International Reading Association and organizer of this symposium, expressed shock at the fact that not a single "substantial reference to the act of reading" was expressed in this comprehensive review. As a result, Guthrie hinted that research people in reading and science education should get together and determine how science teachers select textbooks, how teachers use textbooks and how these practices might be modified to improve science teaching.

Examination of other recent research publications and conference papers in science education similarly suggest a tendency to avoid investigating issues relating reading to science teaching. Some research does tangentially relate science to reading and includes studies evaluating questions and visuals (e.g., Holliday, 1984) and advanced organizers (e.g., Novak, 1979). However, for the most part Guthrie's reaction to the meta-analysis studies is valid. For example, the annual meeting of the National Association for Research in Science Teaching (NARST) being held in New Orleans, April 27-30, 1984, will include only one presentation (Ulerick, in press) directly related to "the act of reading" in science education. Lehman, Koran and Koran (in press) will describe a reading-related study describing aptitude treatment-interaction effects using three forms of the periodic table and written text. Both of these reports will use information-processing models, the type often cited in the research literature of reading education. In addition, Jean-Pascal Souque (in press) will report a qualitative analysis of science textbooks -- the type of descriptive study desperately needed to describe some of the relationships between school science and science textbooks.

Guthrie (1983) concludes his review by stating three reasons for the apparent lack of research attention to the reading area: (1) "reading is not needed in teaching science to students", (2) "or...reading is needed but it is not frequently used", or (3) "(reading) is needed and used but not identified by investigators for isolation and study". Guthrie finally states that "if students read to learn in science education, it appears that researchers from the field do not frequently discuss when, where, or how often, much less how or why."

Capitalizing on Guthrie's reaction might best be accomplished by expanding on his words, "needed" and "used". First, whether much reading is needed or not is a matter of opinion among competent science educators. Some research people, such as John Renner, argue that "reading is not science", while many science teachers apparently see the textbook as the school science curriculum and much of the instruction. People like Renner see textbooks supplanting the effective teaching of true scientific inquiry - a major goal of school science. In this regard, most science educators have observed science classrooms at all levels where quasi-competent teachers relied on textbooks to compensate for their inadequate backgrounds in science and classroom management and where school systems have failed to provide sufficient instructional facilities including "laboratories" equipped to meet the needs of an inquiry-oriented curriculum and of students with varying aptitudes.

Second, whether science textbooks are used or not in the classroom is more a matter of fact than a matter of opinion. An ERIC report (1982) produced by the research group of science educators at The Ohio State University concluded that a few science textbooks are "so deeply entrenched" in our schools "that even the process-oriented (inquiry) science curriculum improvement programs have become textbooks disseminated by commercial publishers". Thus, there seems to be little doubt among many science educators that a majority of science teachers depend heavily upon science textbooks. (Uses of textbooks likely include: (1) a major source of information for the student, (2) a place where students can fill in the gaps after experiencing class lectures and discussions, and (3) a reference source useful in the preparation of science papers and projects.) Whatever the reasons for the extensive use of science textbooks, the fact that such use is pervasive constitutes justification for science educators to evaluate more seriously learning from science texts and other materials, as recommended in Guthrie's review.

A sociological problem worth noting in this context was described by Medvitz and Watson (1979) and has contributed to a disappointing attitude among some science teachers, and to a lesser degree, some university science educators. Specifically, science teachers often see themselves more as representatives of the scientific community in the classroom - "the scientist teaching" - and less as part of the educational community (Medvitz and Watson, 1979), as illustrated by the publications and convention speakers at their professional association, the National Science Teachers Association (NSTA). For example, popular speakers at major NSTA conventions are more likely to be Drs. Linus Pauling, a dual Nobel Prize winner, or Carl Sagan, a competent popularizer of "real" science, and less likely to be speakers such as Drs. Richard Anderson or David Pearson, true leaders in cognitive psychology with educational specializations in reading research.

Moreover, many teachers are uninformed as suggested by the kinds of questions that they seemingly are asking: (1) which readability formula is most appropriate in the evaluation of high school science textbooks? (2) does research specifically tell us how many and what kind of study questions, visuals, boldty typographical cues and explanations of concepts and intellectual processes are best contained in the ideal science textbook? and (3) how do you identify a textbook that students can understand without necessarily requiring teacher intervention? On the other hand, people familiar with research in reading education often argue for: (1) a highly restricted use, or not any use, of readability formulas in the selection of textbooks, (2) a need to understand theoretical issues in reading and their application to practice rather than cookbook-like guidelines sometimes singularly used to discriminate among science textbooks, and (3) an acceptance of the fact that competent teacher intervention in the student use of "appropriate" textbooks is a defensible and desirable goal rather than an instructional condition that should be avoided.

Thus, a central issue in science education research is the necessity to close the gap among researchers in science education, science teachers and reading educators.

Researchers in science education often dismiss or avoid instructional questions dealing with reading and textbooks, as illustrated by their reported studies. Inspection of the literature in science teaching suggests that the instructional process of reading in science classrooms probably does as much harm as good in terms of preparing students to study with science career goals in mind, to vote on political issues in a rational and informed manner, and to apply acquired information and skills to everyday problems. Moreover, one senses a feeling among most researchers in science education that science teachers will someday wake up to the "fact" that hands-on instruction must clearly dominate school science and that activities dealing with reading about science must play a very small - if any - role in the schooling of children.

At the same time, reading research people describe how to "bridge the gap" between authors and readers in a variety of academic and social contexts, how learners construct and reconstruct schemata from texts, how texts can be analyzed and optimally organized, how students can monitor and modify their own comprehension and recall activities, and how texts and their adjunct aids can work together. In my opinion, the problem is that these excellent discussions by reading people often have failed to attract the attention of the science education community, for some reason. Now is the time for some of us to come together and discuss techniques, theoretical issues and a wide variety of research methodologies with a goal of improving science teaching by combining the forces of the two domains, with the assumption that both groups need to be heard, taken seriously and responded to.

What are some of the specific reading-related domains that might be of interest to researchers in science education? First, how can science educators compose, select and use science textbooks and other materials? Second, what are the theoretical and applied relationships between intellectual process skills of science and the reading skills often emphasized a few years ago in the reading literature and now discussed or alluded to under a variety of new rubics? Third, how should we begin to research ways students can best learn from non-school printed materials such as Newsweek and "supplemental" scholarly materials like Scientific American with a goal of helping these young citizens understand and act on academic, social and political issues, such as using pesticides like ethylene dibromide? Fourth, how can reading materials be useful in the teaching of school science using deductive and inductive techniques, using computer terminals and simulation games, using laboratory and field environments, and using non-reading science curriculum programs and non-science school curriculum? Fifth, how can we design pre-service and in-service materials that truly influence the way science is taught?

What are the mechanisms for approaching these goals? First, research representatives from reading and science education must continue to interact at conferences such as this one, through publications and with each other at teacher (research-based) workshops. For example, IRA, NARST and, perhaps, NSTA might jointly produce research monographs and reports describing intense interactions between reading and science domains. Second, representatives from both domains need to acquaint themselves with each others theoretical orientations and not be limited by theoretical issues and methodological techniques. For example, a few people with a background in reading must begin studying the literature in science education and vice versa so that dialogue between the two domains can become productive. Third, a plan for the future must be constructed

and include additional joint efforts. For example, NARST in two years will likely meet in San Francisco with AERA and NSTA. By that time thoughts about our common research concerns will likely mature and be of greater benefit to all.

(References have been placed in the bibliography of this paper to assist science educators interested in pursuing selected study in research in reading education as related to the problems identified by researchers in science education. Readers are encouraged to contact the author regarding the nature of these references.)

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